Accomplishments:

Optical components have been resized by cutting, grinding, edging and polishing as required for research and development relating to the VGS demonstration and flight experiments. Filters have been for surface roughness, figure and fracture resistance as required. The measurements included Talysurf profilometry, WYCO interferometry, and scattering measurements. This effort was accomplished using equipment located in the optical shop of the Optical Systems Branch.

Optical material samples have been prepared for replication by plating of nickel by cutting, grinding, edging and polishing as required to meet specifications of advanced optics such as NGST. The effort included fabrication of a 7.5 inch diameter flat mandrel and a 22 inch spherical segment mandrel. Measurements have been made on the replicated samples from these mandrels and include five replicated mirrors from the smaller mandrel and one from the larger piece. The mandrels were characterized for subsurface damage from included material and surface roughness as required during the polishing steps. Additional lapping efforts included the continued work on Zerodur(R) material. It was required that material fracture studies be performed as required. This effort was accomplished using equipment located in the optical shop of the Optical Systems Branch.

Metrology has been performed on additional samples as required. Additionally it was required to develop some metrology and fabrication techniques and tooling necessary to perform the tasks.

Polishing, metrology, and optical materials characterization tasks have been performed as a part of research and development of replicated optics technology. This included support for the large 10 inch and 20 inch diameter x-ray mirror mandrels to be used for guideline fabrication studies.

2.0 Fabrication and Testing Performance:

2.1 Optical Filter Development (AR&C/VGS)

The primary issues included development of materials and processes to handle the fragile precision pieces. Methods of attachment and material removal were investigated to assure that fracture or chipping of the delicate pieces did not occur. This type edge effect lowers the ultimate strength of the final parts by a factor of 10 or more if it occurs. Procedures such as laser firing of the edges is potentially viable but far more difficult to incorporate than for more conventional lenses or windows. Methods investigated included thermoset mounting of materials as well as soluble mounts of low temperature castable materials such as acrylics for handling during fabrication. Optical inspection of the mechanical condition as well as the performance was required. Pre-loading of the components prior to grinding and polishing processes was implemented to minimize damage. Instrumental processing was used to permit controlled feed rates for the fabrication operations to minimize chances for damaging components. This included implementing new CNC feed grinding and automated polishing procedures.

2.2 Sample materials were prepared in accordance to a test matrix developed to assure cross testing of all pertinent parameters affecting the manufacturing of the delicate parts. Specifications developed by NASA MSFC for the performance parameters were established as the independent variables. The dependent variables include the extent of fracture encountered and the ultimate fracture resistance of the components subjected to controlled tests by MSFC. Also the optical performance of the samples manufactured using variant methods was evaluated. The use of automation by skilled operators was compared to conventional hand fabrication methods. Either method could be used to produce the needed filter components with care.

2.3 Metrology involved microscopy, and interferometry for measurements and observation of the damage incurred during fabrication tests. This did not limit the inspection to subjective observation but will included both the interferometric as well as spectral performance methods for the filters. Stress and fracture measurements involved polarized light measurements to determine the residual and relieved stress conditions. Tooling for holding the parts during metrology is important and was developed as required for this task to be properly performed. The use of birefringent films for mounting stress studies was tested and appeared to be beneficial.

2.4 Material properties of selected filter candidates was compared and an evaluation including mounting and testing of the samples has been performed. Proper coating procedures for candidate filters were tested. Testing and evaluation processes were developed to determine the final processing methods. These processes include cleaning and final mounting or encapsulation. The attenuation of the coatings or encapsulation layers was determined by NASA and the final application processes were determined and evaluated during this effort by UAH. The requirements of the coating will be determined by NASA during the qualification and acceptance test program. UAH has continued to provide support for this effort. UAH continued to provide both optical and material testing support for the fabrication of replicated optics including electroformed optical component mandrel fabrication and new materials and methods determined by MSFC. Additional task efforts included support for the super polishing efforts required to fabricate elaborate optical components such as Wolter x-ray, NGST and other replicated mirrors.

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Title: Optical Fabrication and Measurement: AR&C and NGST

1.0 Background:

The need exists at MSFC for research and development within three major areas:

(1) Automated Rendezvous and Capture (AR&C) including Video Guidance System (VGS)
(2) Next Generation Space Telescope, (NGST)
(3) Replicated Optics.

AR&C/VGS is a laser retroreflection guidance and tracking device which is used from the shuttle to provide video information regarding deployment and guidance of released satellites. NGST is the next large telescope for space to complement Hubble Space Telescope. This will be larger than HST and may be produced in segments to be assembled and aligned in space utilizing advanced mechanisms and materials. The replicated optics will involve a variety of advanced procedures and materials to produce x-ray collimating as well as imaging telescopes and optical components.

Objectives:

1) Resize optical components by cutting, grinding, edging and polishing relating to the VGS demonstration and flight experiments.

2) Prepare optical material samples by cutting, grinding, edging and polishing as required to meet specifications of advanced optics such as NGST.

3) Perform metrology on additional samples as required.

4) Perform polishing, metrology, and optical materials characterization tasks as a part of research and development of replicated optics technology.